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ANSI C37.06.1-2000

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Guide for High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis Designated "Definite Purpose for Fast Transient Recovery Voltage Rise Times"

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Secretariat

Institute of Electrical and Electronics Engineers
National Electrical Manufacturers Association

Approved 03/30/2000

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American National Standard

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Published by

National Electrical Manufacturers Association
1300 N. 17th Street, Rosslyn, Virginia 22209

Printed in the United States of America

FOREWORD (This foreword is not part of American National Standard C37.06.1-2000)

Following reports of circuit breaker failures in applications where very fast TRVs were determined to be the cause, and after thorough analysis of TRV data gathered from all parts of the world, this guide was suggested by the IEEE Switchgear Committee's Task Force on Transient Recovery Voltages. The task force suggested that another class of definite purpose circuit breakers was needed for fast TRV applications. Circuit breakers designated as definite purpose for fast transient recovery voltage rise times applications would be subjected to special fast TRV parameters during both Test Duty 2 (30% of rated short-circuit current) and Test Duty 1 (7% of rated short-circuit current) trials, to demonstrate the capability to interrupt circuits characterized by fast inherent TRVs. A few words of clarification are in order:

- No fast T_2 values or tests are proposed for fault currents greater than 30% of rated short-circuit current.
- The proposed fast T_2 values were chosen to meet 90% of the known fast TRV circuits, but even these fast values do not meet the requirements of all fast TRV applications.
- A circuit breaker that would meet the requirements for definite purpose for fast TRV rise times applications may or may not also meet the requirements for definite purpose circuit breakers for capacitor switching.

It is the purpose of this guide to communicate the suggested values to those in the industry who are interested and who would be in a position to offer comments and suggestions for further revisions.

Table 1B contains values for circuit breakers designed and tested to the circuit breaker ratings contained in ANSI C37.06-2000, Table 1. These circuit breaker ratings have a rated voltage range factor (K) equal to 1.0.

Tables 2B and 3B contain values for circuit breaker ratings contained in ANSI C37.06-2000, Tables 2 and 3.

This guide was initially approved as a "trial-use" guide in 1997. Experience with the trial-use document since then has been favorable, and the document is now approved for more general use as a guide. Only minor editorial revisions have been made to the guide, plus suitable revisions to the text of this "Foreword."

Comments and suggestions relative to the revision of this document should be sent to:

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This guide was processed and approved for submittal to ANSI by Accredited Standards Committee on Power Switchgear C37. Committee approval of the guide does not necessarily imply that all committee members voted for its approval. At the time of its approval, the C37 Committee had the following members:

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A.K. McCabe, Executive Vice-Chairman, HV Standards
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Guide for High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis Designated "Definite Purpose for Fast Transient Recovery Voltage Rise Times"

1 Scope

This guide is issued as a supplement to C37.06 for high-voltage circuit breaker applications where the transient recovery voltages (TRV) rise to the crest value much more rapidly than those specified in ANSI C37.06:

Table 1, Preferred ratings for indoor circuit breakers with voltage range factor K=1.0;

Table 2, Preferred ratings for outdoor circuit breakers 72.5 kV and below; or

Table 3, Preferred ratings for outdoor circuit breakers rated 123 kV and above.

2 Purpose

The purpose of this guide is to provide suggested values of fast transient recovery voltage rise time ratings. The proposed ratings were suggested by the IEEE Switchgear Committee, and apply ONLY to currents in the ranges of 7 percent to 30 percent of Rated Short-Circuit Current. The TRVs for currents more than or equal to 60% of rated short-circuit current remain the same as for general purpose circuit breakers. Circuit breakers not identified by the manufacturer as "definite purpose for fast transient recovery voltage rise times" shall be understood to be "general purpose circuit breakers," meeting the C37.06 standard TRV requirements in table 1, 2, or 3 as appropriate.

3 References

ANSI/IEEE C37.04-1999, *Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*

ANSI C37.06-2000, *AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities*

ANSI/IEEE C37.09-1999, *Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*

ANSI/IEEE C37.011-1994, *Application Guide for Transient Recovery Voltage for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*

4 Rated values

Circuit breakers identified by the manufacturer to be definite purpose for fast transient recovery voltage rise times applications shall be capable of interrupting short-circuits with TRV parameters as specified in the following tables:

Table 1B	TRV parameters for indoor high-voltage circuit breakers designated as definite purpose for fast TRV time-to-peak
Table 2B	TRV parameters for outdoor high-voltage circuit breakers rated 72.5 kV and below, and designated as definite purpose for fast TRV time-to-peak
Table 3B	TRV parameters for outdoor high-voltage circuit breakers 123 kV and above, and designated as definite purpose for fast TRV time-to-peak

Table 1B–Transient recovery voltage parameters fast time-to-peak (T_2) values for definite purpose indoor circuit breakers with voltage range factor K=1.0

Line No.	Rated Maximum Voltage kV, rms (1)	Rated Voltage Range Factor K (1)	Rated Short-Circuit and Short-Time Current kA, rms (1)	Rated Transient Recovery Voltage (1)		Definite Purpose TRV Parameters at 30% of Rated Short-Circuit Current			Definite Purpose TRV Parameters at 7% of Rated Short-Circuit Current		
				Peak Voltage E_2 KV	Time to Peak T_2 μ sec	Current kA, rms	Peak Voltage kV	Time to Peak μ sec	Current kA, rms	Peak Voltage kV	Time to Peak μ sec
	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11
1	4.76	1.0	31.5	8.9	50	9.5	10.1	4	2.2	10.4	7.2
2	4.76	1.0	40	8.9	50	12	10.1	3.9	2.8	10.4	6.5
3	4.76	1.0	50	8.9	50	15	10.1	3.7	3.5	10.4	6
4	8.25	1.0	40	15.5	60	12	17.5	4.5	2.8	18	8
5	15	1.0	20	28	75	6	31.6	8.3	1.4	32.8	15
6	15	1.0	25	28	75	7.5	31.6	7.7	1.8	32.8	13.5
7	15	1.0	31.5	28	75	9.5	31.6	7	2.2	32.8	12
8	15	1.0	40	28	75	12	31.6	6.6	2.8	32.8	11
9	15	1.0	50	28	75	15	31.6	6.2	3.5	32.8	10
10	27	1.0	16	51	105	4.8	58	13	1.1	60	25
11	27	1.0	25	51	105	7.5	58	11	1.8	60	20
12	38	1.0	16	71	125	4.8	80	14	1.1	83	27
13	38	1.0	25	71	125	7.5	80	12	1.8	83	21.5
14	38	1.0	31.5	71	125	9.5	80	11	2.2	83	20
15	38	1.0	40	71	125	12	80	10.5	2.8	83	17.5

Note
(1) See Table 1 of C37.06 for circuit breaker ratings.

Table 2B–Transient recovery voltage ratings fast time-to-peak (T_2) values for definite purpose circuit breakers 72.5 kV and below, including circuit breakers applied in gas insulated substations

Line No.	Rated Maximum Voltage kV, rms (1)	Rated Voltage Range Factor (1)	Rated Short-Circuit and Short-Time Current kA, rms (1)	Rated Transient Recovery Voltage (1)		Definite Purpose TRV Parameters at 30% of Rated Short-Circuit Current			Definite Purpose TRV Parameters at 7% of Rated Short-Circuit Current		
				Peak Voltage E_2 kV, peak	Time to Peak T_2 μ sec	Current kA, rms	Peak Voltage kV, peak	Time to Peak μ sec	Current kA, rms	Peak Voltage kV, peak	Time to Peak μ sec
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
1	15.5	1.0	12.5	29	36	3.8	33	10	0.9	34	14
2	15.5	1.0	20	29	36	6.0	33	8	1.4	34	14
3	15.5	1.0	25	29	36	7.5	33	8	1.8	34	14
4	15.5	1.0	40	29	36	12.0	33	7	2.8	34	11
5	25.8	1.0	12.5	48.5	52	3.8	55	13	0.9	57	21
6	25.8	1.0	25	48.5	52	7.5	55	10	1.8	57	18
7	38.0	1.0	16	71	63	4.8	81	14	1.1	84	25
8	38.0	1.0	20	71	63	6.0	81	13	1.4	84	24
9	38.0	1.0	25	71	63	7.5	81	12	1.8	84	22
10	38.0	1.0	31.5	71	63	9.5	81	11	2.2	84	20
11	38.0	1.0	40	71	63	12.0	81	11	2.8	84	18
12	48.3	1.0	20	91	80	6.0	103	15	1.4	106	28
13	48.3	1.0	31.5	91	80	9.5	103	13	2.2	106	23
14	48.3	1.0	40	91	80	12.0	103	12	2.8	106	21
15	72.5	1.0	20	136	106	6.0	154	19	1.4	159	35
16	72.5	1.0	31.5	136	106	9.5	154	16	2.2	159	28
17	72.5	1.0	40	136	106	12.0	154	15	2.8	159	25

Note
(1) See Table 2 of C37.06 for circuit breaker ratings.

Table 3B–Transient recovery voltage ratings fast time-to-peak (T_2) values for definite purpose circuit breakers 123 kV and above

Line No.	Rated Maximum Voltage kV, rms (1)	Rated Voltage Range Factor (1)	Rated Short-Circuit and Short-Time Current kA, rms (1)	Rated Transient Recovery Voltage (1)		Definite Purpose TRV Parameters at 30% of Rated Short-Circuit Current			Definite Purpose TRV Parameters at 7% of Rated Short-Circuit Current		
				Peak Voltage E_2 kV, peak	Time to Peak T_2 μ sec	Current kA, rms	Peak Voltage kV, peak	Time to Peak μ sec	Current kA, rms	Peak Voltage kV, peak	Time to Peak μ sec
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
1	123	1.0	20	216	275	6	245	28.3	1.4	253	48.7
2	123	1.0	40	216	260	12	245	23.5	2.8	253	36.5
3	123	1.0	63	216	260	19	245	21.4	4.4	253	31.0
4	145	1.0	20	255	330	6	288	30.9	1.4	299	53.4
5	145	1.0	40	255	310	12	288	25.8	2.8	299	40.0
6	145	1.0	63	255	310	19	288	23.5	4.4	299	34.0
7	145	1.0	80	255	310	24	288	22.6	5.6	299	31.2
8	170	1.0	16	299	395	8	338	35.2	1.1	350	63.4
9	170	1.0	31.5	299	360	9.5	338	29.1	2.2	350	47.0
10	170	1.0	40	299	360	12	338	27.8	2.8	350	43.2
11	170	1.0	50	299	360	15	338	26.4	3.5	350	35.7
12	170	1.0	63	299	360	19	338	25.4	4.4	350	36.7
13	245	1.0	31.5	431	520	9.5	487	34.8	2.2	505	56.2
14	245	1.0	40	431	520	12	487	33.3	2.8	505	51.6
15	245	1.0	50	431	520	15	487	31.6	3.5	505	47.4
16	245	1.0	63	431	520	19	487	30.3	4.4	505	43.8
17	362	1.0	40	637	775	12	720	40.7	2.8	745	63.2
18	362	1.0	63	637	775	19	720	37.1	4.4	745	55.7
19	550	1.0	40	968	1325	12	1094	49.0	2.8	1133	76.1
20	550	1.0	63	968	1325	19	1094	44.7	4.4	1133	63.9
21	800	1.0	40	1408	1530	12	1591	60.7	2.8	1647	94.1
22	800	1.0	63	1408	1530	19	1591	55.3	4.4	1647	79.9

Note
(1) See Table 3 of C37.06 for circuit breaker ratings.